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A buoyancy based convection and diffusion-cloud schemes

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A new and consistent set of convection and diffusion-cloud schemes is described. The main concept ensuring the consistency of the whole system is the buoyancy. Concerning the convection scheme, the buoyancy constitutes the forcing term of the convective vertical velocity, which is then used to define the mass flux, the entrainment and detrainment rates, and the triggering condition. The buoyancy is also used in its vertically integrated form to determine the closure condition. Concerning the diffusion-cloud scheme, the buoyancy constitutes the forcing term of the Richardson number (together with the wind shear), which is then used to compute the mixing length, the turbulent kinetic energy, and the stability functions, all three elements defining the turbulent coefficients. Moreover, the buoyancy is also used to obtain the subgrid-scale condensation, which is intrinsically linked to the turbulence through an iterative computation of the departure of the mean state from saturation. A validation of this scheme is shown. First, Single Column Model (SCM) mode integrations are allowing detailed comparisons with observed and explicitly simulated data. Both deep and shallow convection case-studies are considered. The SCM is able to satisfactorily reproduce key elements of the physics, such as the convective mass flux and the apparent heat source and moisture sink. Nevertheless, the abrupt transition between the diffusive and convective regime tends to produce an overestimation of the drying above that transition, for the shallow convection case. Second, a General Circulation Model (GCM) ten-year simulation is providing a mean to assess the model climate against the observed one. The basic global budgets are balanced, with values corresponding the present knowledge of these quantities, by tuning a few parameters of the microphysics. There is a good agreement in the overall pattern of simulated versus observed mean sea level pressure and precipitation seasonal means.